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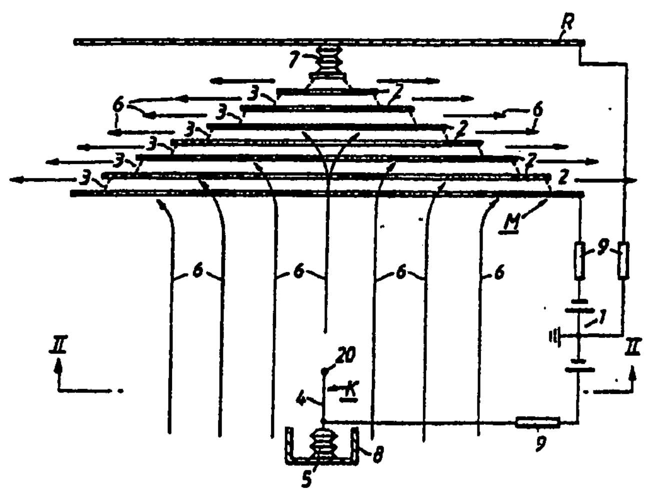

(57) Abstract

An arrangement for generating an air flow and cleaning the air with the aid of an electric ion wind, this arrangement including a corona electrode (K) and a target electrode (M) spaced from the corona electrode, and in which each electrode is connected to a respective pole of a direct voltage source (1) whose voltage is such as to generate a corona discharge on the corona electrode (K). The target electrode (M) has essentially the form of an obtuse cone or has a generally spherical form and has distributed therein a plurality of air through-flow openings (3), whereas the corona electrode (K) has the form of a wire-like electric element which extends along the symmetry axis of the target electrode (M) so as to be generally equidistant from all parts of the target electrode. The target electrode (M) may advantageously be provided with a large, circular, central opening (10) centrally opposite the corona electrode (K). The target electrode (M) advantageously comprises a plurality of flat, thin, ring-shaped electrode elements of mutually different diameters which are arranged parallel with one another such as to define interspaces (3) in planes at right angles to the symmetry axis of the target electrode (M). A reflector electrode (R) may be positioned at a distance from the target electrode (M) on the opposite thereof relative to the corona electrode (K) and is connected to a potential of the same polarity relative to the target electrode (M) as the corona electrode (K).

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Apparatus for Generating and Cleaning an Air Flow.

The present invention relates to an arrangement for generating an air flow with the aid of a so-called electric ion-wind, and for cleaning the air of contaminants.

It is known that an air flow, usually referred to as a corona wind or an ion wind, can be generated with the aid of an arrangement which includes a corona electrode and a target electrode which are spaced from one another and each of which is connected to a respective pole of a direct voltage source, wherein the form of the corona electrode, the potential difference and the distance between the corona electrode and the target electrode are such as to generate a corona discharge on the corona electrode. The generated air ions migrate or wander quickly to the target electrode under the influence of the electric field that exists between the corona electrode and the target electrode and there surrender their electric charge. During their travel to the target electrode, the ions collide with neutral air molecules, thereby transferring electrostatic forces to these latter molecules which are therefore drawn towards the target electrode. This results in an air flow, a so-called corona or ion wind, which moves in a direction away from the corona electrode and towards the target electrode. Different embodiments of this basic type of air-flow generating arrangement are disclosed, for instance, in International Patent Applications PCT/SE85/00538, PCT/SE87/00595, and PCT/SE88/00365. Arrangements which are based on this principle are also found in even older patent applications. It would seem, however, that PCT/SE85/00538 is the first publication to describe in more detail those parameters which determine the magnitude of the ion wind, more specifically to describe that the force which drives the air flow in a given direction, i.e. the ion wind, is dependent on the product of the magnitude of the ion current and the distance travelled in the direction concerned.

It is also known that in addition to generating an air flow an arrangement of the fundamental kind described above can be used also to cleanse the air flow from aerosol contaminants, i.e. solid particles and/or liquid droplets. This is because the air ions generated by the corona discharge are instrumental in charging the airborne contaminants with an electric charge of the same polarity as the air ions, and consequently the contaminants will tend to precipitate electrostatically and adhere to the target electrode and possibly to other electrodes or surfaces that have the same electric polarity as the target electrode.

It has been found difficult in practice, however, to construct an air-flow generating and air-flow cleansing or purifying arrangement of the aforesaid principle kind which is able to fulfill in reality all of the demands that can be reasonably placed on such an arrangement, these demands being primarily:

- The volumetric air throughput generated by the arrangement per unit of time shall be large in relation to the dimensions of the arrangement;

- the arrangement shall be effective in cleansing the air flow of aerosol contaminants;

- the arrangement shall be operationally reliable and with small risk of electric spark-overs or spark discharges, despite the unavoidable collection of dirt on the arrangement components that results from the cleaning function of the arrangement;

- the arrangement must be safe to touch, despite the high voltages used, in the order of tens of kilovolts;

-the arrangement shall be of simple and inexpensive manufacture and simple to clean;

-the amount of potentially dangerous and irritating substances generated by the corona discharge, such as primarily ozone and oxides of nitrogen, but also other harmful substances, must be very small in relation to the volume of air that passes through the arrangement per unit of time.

It has been found that the inventive arrangement will fulfill all of these demands in a highly satisfactory manner and that the arrangement therewith provides a practical and highly effective solution to the problem of circulating air in populated spaces, such as living accommodations, work places, office premises and public premises while cleaning the air at the same time. Among other things, the inventive arrangement can be used very effectively as kitchen extractor, instead of the generally inefficient extractor fans used at present. It has also been found that the inventive arrangement will also eliminate the harmful decomposition products of radon gases with great efficiency.

The inventive arrangement is characterized by the features set forth in the following Claims.

The invention will now be described in more detail with reference to a number of exemplifying embodiments thereof illustrated schematically in the accompanying drawings, in which

Figure 1 is a schematic axial sectional view of a first embodiment of the invention;

Figure 2 is a view of the embodiment shown in Fig. 1 and seen from the line II-II in said Figure;

Figures 3 and 4 are views similar to the views shown in Figs. 1 and 2, and illustrate a second embodiment of the inventive arrangement; and

Figures 5-7 illustrate a third embodiment of the inventive arrangement.

The exemplifying embodiment of the inventive arrangement illustrated schematically in Figs. 1 and 2 includes a corona electrode, generally referenced K, and a target electrode, generally referenced M, each of said electrodes being connected to a respective pole of a direct voltage source 1. The direct voltage source 1 will preferably have a central earth terminal, so that the electrical potentials of the corona and target electrodes will be symmetrical in relation to earth, whereby the total high voltage potential of the arrangement in relation to earth will be the lowest possible for a given potential difference between the two electrodes K and M. In the case of the illustrated embodiment, the corona electrode K has a positive potential, whereas the target electrode M has a negative potential. The respective polarities of the electrodes, however, may be the reverse of those stated.

In this embodiment, the target electrode M is comprised of a number of flat ring-shaped electrode elements 2 of small thicknesses. The electrode elements can therefore be considered to have the form of annular lamellae. The ring-shaped electrode elements 2 have mutually different diameters and are disposed coaxially with one another such as to leave therebetween spaces 3 which form air-flow openings through the target electrode M. As shown schematically in broken lines in the drawings, the various ring-shaped electrode elements forming the target electrode are mutually connected electrically, and preferably also mechanically, so as to form a continuous target electrode unit with the ring-shaped air-throughflow openings 3 between the different elements 2. The target electrode M will thus extend around a contemplated or imaginary curved surface, which has generally the form of a conical surface with an obtuse top angle, or a generally spherical form. A target electrode M of the kind used in the Figure 1 embodiment can be produced advantageously by punching the electrode from a sheet of the material from which the

ring-shaped electrode elements 2 are formed, with said elements mutually connected by tabs punched in the sheet, as shown with broken lines in the drawings, such that the target electrode unit can be obtained by drawing it from the sheet in a concertina-like fashion.

In the case of the illustrated embodiment, the corona electrode K has the form of a relatively short wire-like electrode element 4 which is disposed along the symmetry axis of the target electrode M in a position such that the corona electrode element 4 is spaced generally equidistant from each and every part of the target electrode M, i.e. from all of the ring-shaped electrode elements 2 included in the target electrode M. The corona electrode K can thus be said to lie in the proximity of the centre of curvature of the contemplated curved or arched surface around which the target electrode extends. The end of the wire-like electrode element 4 of the corona electrode K distal from the target electrode M is attached to and carried by an insulator 5, whereas that end of the electrode element 4 which faces towards the target electrode M is provided with a body 20 whose diameter is generally larger than the diameter of the wire-like electrode element 4. This will prevent the occurrence of punctiform corona discharges at the free end of the electrode element 4. Instead, the corona discharge will occur along and around the circumferential surface of the wire-like electrode element 4. Thus, in the case of this embodiment of the inventive arrangement, the corona electrode is essentially constructed in accordance with the principles disclosed in the International Application PCT/SE86/00548, and therefore affords the advantages described therein.

The ion wind generated by a corona discharge at the corona electrode K and travelling from the corona electrode towards the target electrode M will drive an air flow through the arrangement, as shown by the arrows 6. This air flow thus passes through the annular spaces between mutually adjacent

ring-shaped electrode elements 2 and is forced to pass closely adjacent to the electrode elements 2.

When the target electrode has the form shown in Figure 1, the corona electrode will "see" a large and continuous, or unbroken, target electrode surface. This makes it possible to maintain a stable and highly effective corona discharge at the corona electrode K with the aid of relatively moderate potential differences between the corona electrode K and the target electrode M and, at the same time, with a significant distance between the corona electrode and the target electrode. As a result of the long distance between the two electrodes K and M, and the therewith significant migratory path of the air ions from the corona electrode to the target electrode, a highly significant volume of air can be caused to pass through the arrangement, even when operating with a small corona current. Obviously, a relatively moderate potential difference between the corona and the target electrodes is advantageous, since this will reduce the need to insulate the arrangement against high voltages. The relatively moderate potential difference between the corona and the target electrodes K and M together with the long distance between said two electrodes will also eliminate the risk of sparkover between the two electrodes and also the risk of spark discharges on the target electrode caused by the dirt collections on the target electrode. The low corona current which can be used with the inventive arrangement affords the very important advantage that the potentially harmful and irritating substances generated by the corona discharge, such as ozone and oxides of nitrogen in particular and also other substances, can be kept to an acceptable low level in relation to the volume of air that flows through the arrangement per unit of time. The quantities in which such harmful and irritating substances are generated is roughly proportional to the value of the corona current.

Thus, an inventive arrangement constructed in the manner illustrated has been found to provide a significant flow of air

through the arrangement with the aid of a very small corona current. A tested arrangement of this construction included a target electrode in which the largest ring-shaped electrode element 2 had an outer diameter of 35 cm. The distance between the free end of the corona electrode K and the plane of the target electrode element 2 of largest diameter was about 15 cm. The corona electrode K was connected to the potential +20 kV, whereas the target electrode M was connected to the potential -20 kV, the total corona current being as small as 10-15 μA. This resulted in an hourly volumetric throughput of about 120 m^3. Generally speaking, in the case of the inventive arrangement, an advantage is afforded when the distance between the corona electrode and the nearest part of the target electrode is at least 12 cm. Furthermore, the extension of the target electrode is advantageously such that as seen from the corona electrode it includes a visual angle of not greater than 180°.

The aerosol contaminants, solids and liquid droplets, suspended in the air flow will be charged electrically with the same polarity as the potential of the corona electrode K and will therefore adhere to the ring-shaped electrode elements 2 of the target electrode M, since the air passes in close proximity to said elements 2 during its passage through the spaces located between the electrode elements 2. The contaminants are precipitated primarily on that side of the ring-shaped electrode elements which faces towards the corona electrode, and will be held firmly thereon by the influence exerted by the electric field that prevails between the corona and the target electrodes K and M. This applies in particular to all large contaminants, such as dust balls, hair and the like. Despite the dirt deposits on the side of the target electrode elements 2 that face towards the corona electrode K, there is no risk of sparking between the corona electrode K and the target electrode M or of spark discharges from the target electrode elements 2, due to the significant distance between the two electrodes K and M.

Cleaning of the air flow can be improved still further, particularly with regard to small size contaminants, by placing a reflector electrode R on the opposite side of the target electrode as seen in relation to the corona electrode, in the manner shown in the illustrated embodiment of the inventive arrangement, and by connecting the reflector electrode to an electric potential of the same polarity in relation to the potential of the target electrode as the potential of the corona electrode. In the case of the illustrated embodiment, the reflector electrode R is connected to earth. The electric field that prevails between the reflector electrode R and the target electrode M is effective to cause those contaminants which remain in the air flowing through the spaces 3 between adjacent electrode elements 2 to adhere to and remain on the rear sides of respective target electrode elements 2. This further cleaning of the air flow is highly effective, since the air flow passes closely adjacent to the rear sides of the target electrode elements 2.

It is characteristic of the inventive arrangement that said arrangement need not be housed in a casing or like structure in order to guide the flow of air through the arrangement. This affords considerable advantages, since, among other things, the arrangement is simpler and less expensive than would otherwise be the case. Furthermore, the absence of surrounding casing walls means that the corona discharge occurring on the corona electrode will not then be disturbed and screened, as might possibly be the case if such surrounding walls were present. Thus, in the case of an inventive arrangement constructed in the manner shown by way of example in Figures 1 and 2, all that is required is the provision of suitable means for supporting the reflector electrode R, which in turn carries the target electrode M through the intermediary of an insulator 7, and also the provision of suitable means for supporting the insulator 5 of the corona electrode K. In the case of the illustrated embodiment, the insulator 5 is arranged in a cup-shaped holder 8 made of electrically insulating material. One advantage of the holder

8 is that it prevents soiling or dirtying of the corona electrode by the air flowing past said electrode. This is particularly advantageous when the air flowing past the electrode has a high moisture content and/or contains water droplets, for example as would be the case when the inventive arrangement is used as an extractor for removing the odour of cooking food in kitchens.

It has been found that the inventive arrangement is highly effective in this regard, and if desired can be mounted in a compartment above a kitchen stove, or may be installed freely without being housed. Since the inventive arrangement runs silently, it may be kept in operation continuously to no detriment, thereby removing effectively the smells generated when cooking food. This is not the case with present day extractor fans, which are often switched off or set to a low air throughput as soon as the actual process of cooking food is completed, because of the relatively high level of noise generated by such extractors. The smell of cooking will still prevail, however, and will unavoidably spread to surrounding rooms.

An arrangement constructed in accordance with the inventive principles can be modified in several ways in relation to the aforedescribed exemplifying embodiment illustrated in Figs. 1 and 2.

For example, the target electrode M can be given any one of several different configurations. For instance, it may be constructed from ring-shaped, mutually parallel and mutually spaced electrode elements which instead of being flat as in the case of the earlier embodiment, are slightly conical or arched, so that the shape and extension of the elements will function to deflect the direction of air flow more gradually. It is also conceivable for the ring-shaped electrode elements to have a cylindrical configuration, so that the direction of air flow will not be deflected to any appreciable extent. The target electrode may also be given the form of a net-like or

grid-like structure which extends around an imaginary curved surface.

The reflector electrode may also have any one of a number of different configurations. For instance it need not be an impervious structure, as in the case of the illustrated embodiment, but also have form of a net-like or gridlike structure or may be formed similar to the target electrode. An advantage is afforded when the reflector electrode is arranged in parallel, spaced relationship with the target electrode, which gives a stronger magnetic field between the target electrode and the reflector electrode and therewith more effective cleaning of the air flow between the target electrode and the reflector electrode. Finally, an arrangement constructed in accordance with the invention is also able to operate without the provision of a reflector electrode, although the cleaning effect will then be poorer. This has less importance, however, when the inventive arrangement is to be used primarily to generate an air throughflow, and is not intended to clean the air efficiently at the same time.

Although the arrangement described above with reference to Figures 1 and 2 functions satisfactorily, it is found that in some circumstances problems can occur in the form of air eddy-currents and generally chaotic air flows at the centre of the target electrode, i.e. at the "tip" of the obtusely conical target electrode M of the Figures 1 and 2 embodiment and particularly when desiring a large volumetric throughflow of air. Such problems can be eliminated effectively, by providing the target electrode with a generally circular, large opening in its central part, axially opposite the corona electrode.

Figures 3 and 4 illustrate schematically and by way of example one such arrangement according to the invention. In the case of this arrangement, the target electrode M has generally the same configuration as the target electrode of the Figures 1 and 2 embodiment and is constructed of ring-shaped

flat electrode elements 2 which have mutually different diameters and which are arranged parallel with one another and define spaces 3 therebetween, so as to form together an air-permeable, obtusely conical target electrode. However, the target electrode of the Figures 3 and 4 embodiment lacks the electrode elements 2 of smallest diameter, such that in this case the target electrode M will present in the centre thereof a relatively large and circular opening 10 axially opposite the corona electrode K. The target electrode M is supported by a base plate 12 and is isolated therefrom by insulators 11. The plate 12 contains the high voltage unit of the arrangement and also supports the corona electrode K through the intermediary of an arm 13. The arrangement also includes a reflector electrode R, which in the case of this embodiment extends generally parallel with the target electrode M and is provided with a central opening 14 which corresponds essentially to the opening 10 in the target electrode M. The reflector electrode R is impervious in other respects. This arrangement also includes a dish-like, further electrode 15 which is arranged parallel with and spaced from the reflector electrode R on the opposite side thereof in relation to the target electrode. In the case of this embodiment, the further electrode 15 is impervious and extends over the opening 14 in the reflector electrode R. The electrode 15 is carried by the base plate 12 and in turn carries the reflector electrode R, through the intermediary of insulators 16.

Similar to the embodiment described above with reference to Figs. 1 and 2, a corona discharge on the corona electrode K will give rise to an air flow in the direction of the target electrode M. As with the embodiment according to Figs. 1 and 2, part of the air flow will pass through the spaces 3 between the ring-shaped electrode elements 2 of the target electrode M, whereas the predominant part of the air flow will pass through the central opening 10 in the target electrode M. The first mentioned part of the air flow is deflected in its passage between the electrode elements 2 of the target

electrode M and flows radially outwards between the rear side of the target electrode M and the reflector electrode R, this part of said air flow being cleansed of contaminants in the manner described with reference to Figures 1 and 2. The air flowing through the central opening 10 of the target electrode M continues through the central opening 14 in the reflector electrode R and then flows radially outwards between the reflector electrode R and the further electrode 15. The air is therewith cleansed of impurities, because the further electrode 15 is connected to an electric potential which differs from the electrical potential of the reflector electrode R, such that an electrostatic field will prevail between the further electrode 15 and the reflector electrode R. This electrostatic field is effective to cause the contaminants contained by the air flow and charged electrically with the polarity of the corona electrode K to settle either on the reflector electrode R or on the further electrode 15, depending on which polarity the further electrode 15 has in relation to the reflector electrode. For instance, the potential of the reflector electrode may be positive or negative in relation to the potential of the reflector electrode R. In one case, the contaminants will settle on the reflector electrode R and in the other on the further electrode 15. This will also result in effective cleaning of the air that passes through the central opening 10 of the target electrode M.

The largest ring-shaped electrode element 2 of the target electrode M of a tested arrangement according to Figure 3 and 4 had an outer diameter of about 36 cm, and the distance between the free end of the corona electrode K and the central opening 10 in the target electrode M was about 19 cm. The diameter of the opening 10 was about 12 cm. The reflector electrode R was spaced at a distance of about 2 cm from both the target electrode M and the further electrode 15. The corona electrode K was connected to the potential +15 kV, whereas the target electrode was connected to the potential -15 kV, and the total corona current was only about 4-6 μA. This gave an air throughflow of about 70 m^3/h. At least 99%

of the contaminants contained in the air passing through the arrangement was removed. The volume of air that passes through the arrangement may be decreased or increased by decreasing or increasing the strength of the corona current. A larger air throughput can also be achieved, of course, by placing several inventive arrangements side-by-side. It is also possible to use two of the arrangements according to Figs 3 and 4 placed axially in relation to one another, with the base plates 12 facing one another and preferably combined to form a single unit.

The arrangement illustrated in Figures 3 and 4 can also be constructed without the further electrode 15. In the case of this variant, the reflector electrode need not be provided with a central opening 14, such that the electrode will also extend over the central opening 10 in the target electrode M. The air flowing through the central opening 10 in the target electrode M will then also be deflected and flow radially outwards between the rear side of the target electrode M and the reflector electrode R, while being cleaned in the aforesaid manner under the influence of the electrostatic field prevailing between the target electrode M and the reflector electrode R. It will be realized, however, that in this case a large volume of air will flow out radially in the space between the target electrode M and the reflector electrode R. As a result the air velocity will be higher and cleaning of the air more difficult to achieve. Consequently, the reflector electrode R may be provided with a central opening in the same manner as that illustrated in Figs. 3 and 4, and the opening fitted with an air-permeable filter. In this case, a large part of the air flowing through the central opening 10 in the target electrode M will flow out through the central opening in the reflector electrode R and be cleaned. At the same time, the volume of air flow in the space between the target electrode M and the reflector electrode R, and therewith also the speed of the air flow, is reduced to a corresponding degree, which results in more effective cleaning of this air flow.

An inventive arrangement according to this latter variant is illustrated by way of example in Figures 5, 6 and 7. Figures 5-7 show two air purifiers constructed in accordance with this embodiment and combined and arranged as an extractor for use in kitchens to dispel cooking odours. As with earlier illustrations, the target electrodes are referenced M, the corona electrodes are referenced K and the reflector electrodes are referenced R. The air-permeable filter elements mounted in the central openings of the reflector electrodes R opposite the central openings of the target electrodes M are referenced 17. As will be seen clearly from Figs. 6 and 7, the target electrodes M and the reflector electrodes R are, in this case, mounted in respective large, rectangular plates 18 and 19, which are mutually parallel and spaced apart. The air passing through the two purifiers will thus exit sideways between the plates 18 and 19, said plates having the same potential as the target electrodes M and the reflector electrodes R respectively. Together the plates 18 and 19 form an electrostatic capacitor separator and therewith coact to clean the through-flowing air still further.

When an inventive arrangement is installed in a generally highly moist environment, for instance above a kitchen stove or oven, it is unavoidable that part of the moisture in the air will condense and settle in the form of droplets on the electrodes of the arrangement, and therewith primarily on the target electrode, which is the first to meet the incoming air flow. Such an occurrence will not jeopardize the function of the arrangement. However, water droplets that adhere to the outermost edge of the target electrode, which is connected to high potential, may give rise to spark discharges. Although such discharges will not impair the function of the arrangement, they cause a crackling noise which can be experienced as being disturbing. Such an occurrence can be prevented, however, by providing said edge with a hygroscopic covering, e.g. a fabric, felt, foam-rubber or cellular plastic covering, which will absorb the water droplets.

Because it is not necessary to enclose the inventive arrangement in a casing or housing, the arrangement can also be used effectively as an ionizer for rendering harmless any free radon daughters that may be present in the space in which the arrangement is installed. It is well known that radon gases constitute a serious health problem, since they decompose into so-called radon daughters which, if inhaled, constitute a very serious risk to the health. Radon daughters are electrically charged and highly mobile, and consequently some of them will fasten on and bind to contaminants and impurities present in the air and are therewith less harmful if inhaled and are also more easily removed with the aid of a suitable air purifier, such as with the aid of an arrangement constructed in accordance with the present invention, for instance. The remaining radon daughters, on the other hand, represent a much more dangerous threat to the health and are more difficult to control. It is known that free radon daughters can be rendered harmless to a great extent with the aid of an ionizer placed in the room concerned, so as to create an ion field therein. Under the influence of this ion field, the electrically charged and highly mobile free radon daughters are driven to the surfaces of room-defining structures and also to other surfaces in the room, such as the surfaces of furniture, etc, and there fasten and become unharmful. An arrangement which is constructed in accordance with the present invention has been found to function extremely well as an ionizer, besides functioning effectively as an air purifier.

Despite the fact that the inventive arrangement may have been installed openly, i.e. not housed in a casing, and despite the fact that the target electrode M and the corona electrode K, and possibly other electrodes, are connected to high electric voltages, the arrangement will not be dangerous to touch, provided that the various electrodes are connected to the direct voltage source 1 through very high ohmic resistors 9 (see Figures 1 and 2). Even though one of the electrodes may be touched unintentionally while the arrangement is in

operation, these high ohmic resistors will limit the occurring currents to values which are so small, e.g. below 300 μA, as to eliminate all risk, and also any feeling of discomfort. Such high ohmic resistors can, of course, be used readily, since the total corona current is only in the order of 10 μA. As will be understood, because of the very low currents that prevail when the arrangement is in operation, the target electrode M, the reflector electrode R and the further electrode 15 may be made of weakly conductive or semi-conductive material to no detriment, for example from weakly conductive paper or plastic material, or from anti-static-treated material.

CLAIMS

1. An arrangement for generating an air flow and cleansing the air with the aid of an electric ion wind, this arrangement including a corona electrode (K), and a target electrode (M) spaced from said corona electrode, and in which each electrode is connected to a respective pole of a direct voltage source (1) whose voltage is such as to generate a corona discharge on the corona electrode (k), **characterized in that** the target electrode (M) extends around an imaginary curved surface and has disposed thereon a plurality of air through-flow openings (3), wherein the imaginary curved surface has the form of an obtuse cone or a generally spherical form; and in that the corona electrode (K) has the form of a wire-like electrode element (4) whose longitudinal extension coincides generally with the symmetry axis of the target electrode (M) on the concave side of said target electrode.

2. An arrangement according to Claim 1, **characterized in that** the target electrode (M) includes a plurality of mutually electrically connected ring-shaped and generally lamella-like electrode elements (2) which have diameters of mutually differing sizes and which are disposed in generally parallel and spaced relationship with one another such as to define said air through-flow openings (3) therebetween.

3. An arrangement according to Claim 2, **characterized in that** the lamella-like electrode elements (29) have a side surface generally facing towards the corona electrode (K).

4. An arrangement according to Claim 2, **characterized in that** the electrode elements are comprised of flat rings disposed in a plane which is generally perpendicular to the symmetry axis of the target electrode (M).

5. An arrangement according to any one of Claims 2-4, **characterized in that** the electrode elements (2) are so arranged that as seen from the corona electrode (K) they appear jointly to form a generally continuous, unbroken surface.

6. An arrangement according to Claim 1, **characterized in that** the target electrode (M) is comprised of a net-like or grid-like structure.

7. An arrangement according to any one of Claims 1-6, **characterized in that** the end of the wire-like corona electrode (K) that faces towards the target electrode (M) is provided with a body (20) whose dimensions are substantially greater than the diameter of the electrode element (K).

8. An arrangement according to any one of Claims 1-7, **characterized in that** the corona electrode (K) is so placed in the proximity of the center of curvature of the imaginary curved surface as to be located substantially equidistant from each and every part of the target electrode (M).

9. An arrangement according to any one of Claims 1-8, **characterized in that** the distance between the target electrode (M) and the corona electrode (K) is at least 12 cm.

10. An arrangement according to any one of Claims 1-9, **characterized in that** the extension of the target electrode (M) around the imaginary curved surface is such as to include an angle of view of less than 180° as seen from the corona electrode (K).

11. An arrangement according to any one of Claims 1-10, **characterized in that** the arrangement further includes a reflector electrode (R) which is spaced from the target electrode (M) on that side thereof which is opposite to the corona electrode (K); and in that the reflector electrode (R) is connected to an electric potential of the same polarity relative to the polarity of the target electrode (M) as the potential of the corona electrode (K).

12. An arrangement according to Claim 11, **characterized in that** the reflector electrode (R) extends generally parallel to the target electrode (M).

13. An arrangement according to Claim 11 or 12, **characterized in that** the reflector electrode (R) is impervious.

14. An arrangement according to Claim 11 or Claim 12, **characterized in that** the reflector electrode (R) is permeable to air.

15. An arrangement according to any one of Claims 1-10, **characterized in that** the target electrode has a generally circular opening (10) axially and centrally opposite the corona electrode (K).

16. An arrangement according to Claim 15 and to any one of Claims 11-14, **characterized in that** the reflector electrode (R) also extends over the circular opening (10) in the target electrode (M).

17. An arrangement according to Claim 15 and any one of Claims 11-14, **characterized in that** the reflector electrode (R) is provided with an opening (14) generally opposite the circular opening (10) in the target electrode (M), and in that an air-permeable filter (17) is mounted in the opening in the reflector electrode (R).

18. An arrangement according to Claim 15 and any one of Claims 11-14, **characterized in that** the reflector electrode (R) is provided with an opening generally centrally opposite the circular opening (10) in the target electrode (M), in that a further electrode (15) is placed at a distance from and generally parallel with the reflector electrode (R) on the opposite side thereof in relation to the target electrode (M); and in that the further electrode (15) is impervious and also extends over the opening (14) in the reflector electrode (R) and is connected to an electric potential which differs from the potential of the reflector electrode (R).

Fig. 1

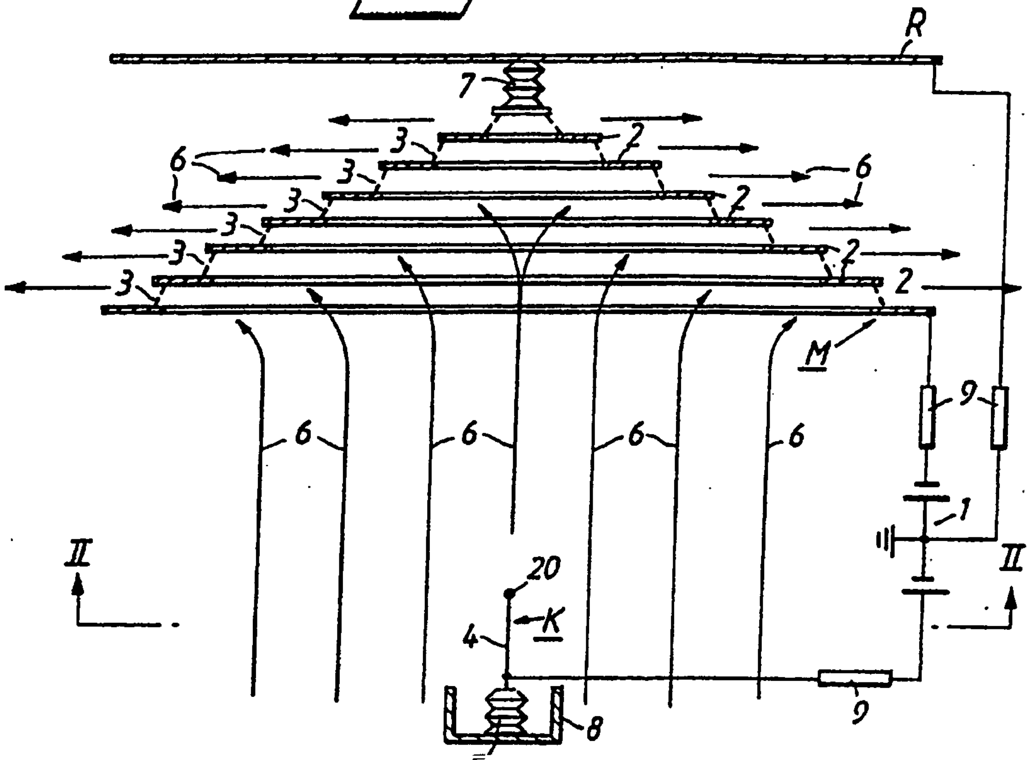


Fig. 2

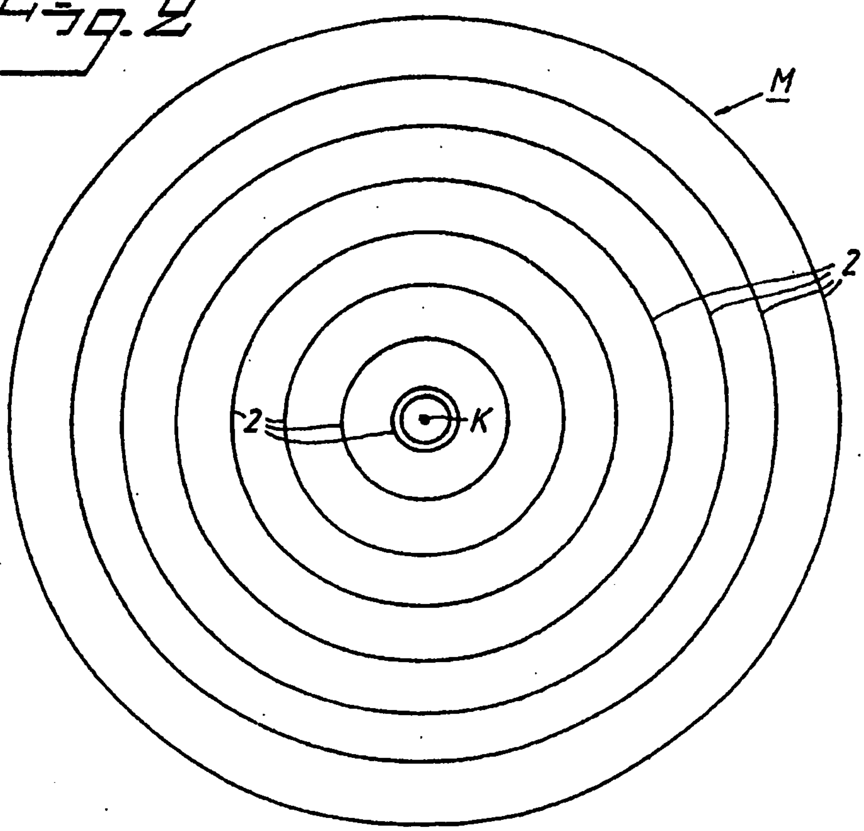


Fig. 3

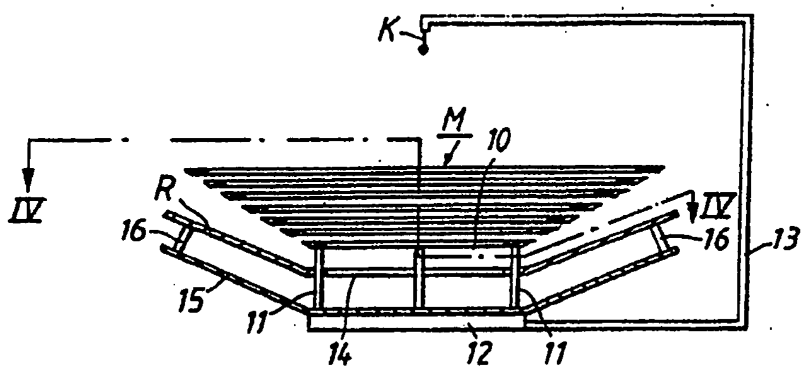


Fig. 4

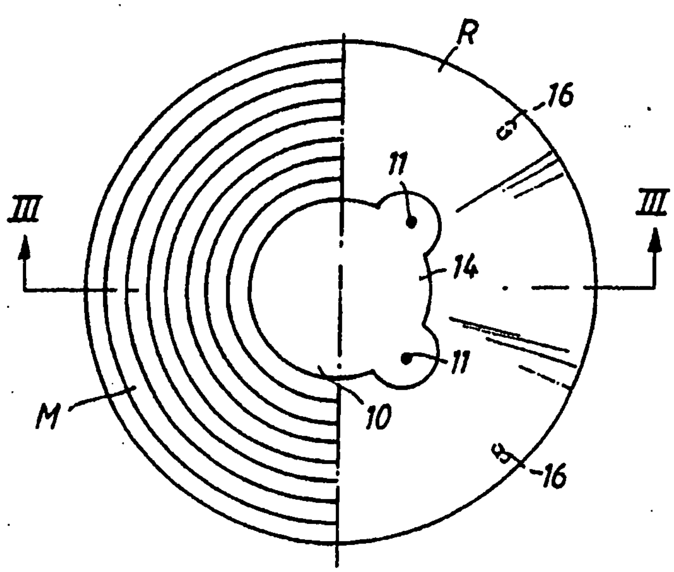


Fig.5

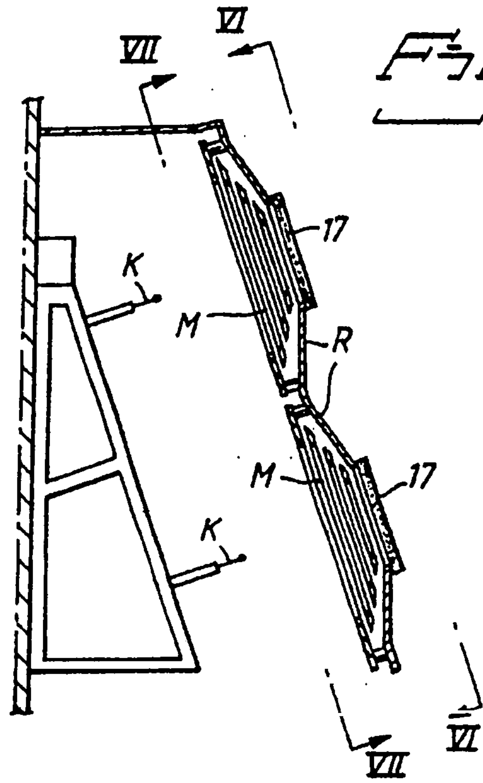


Fig.6

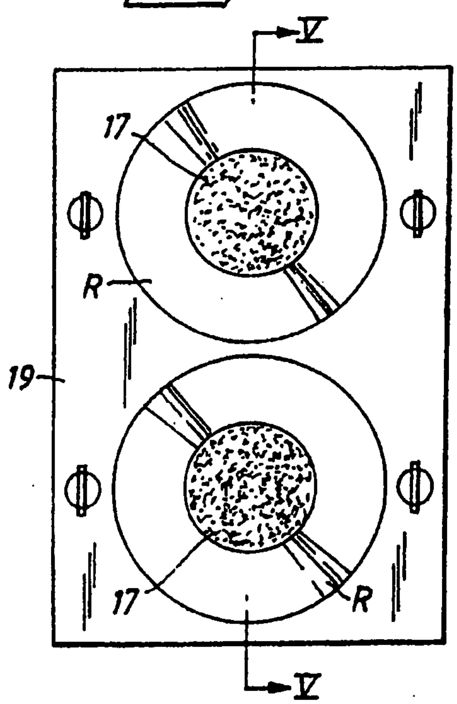
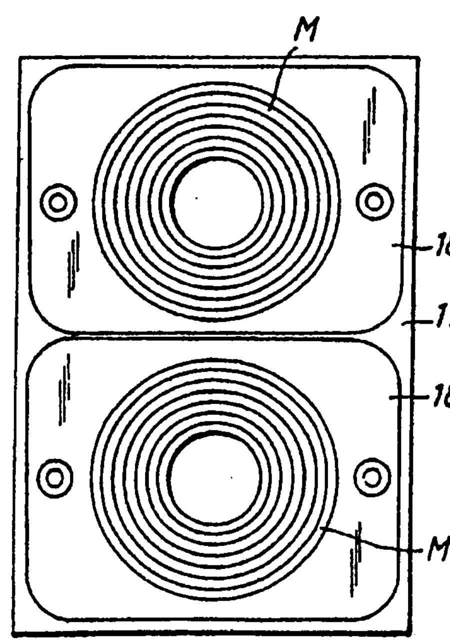


Fig.7



INTERNATIONAL SEARCH REPORT

International Application No PCT/SE 91/00664

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC5: B 03 C 3/04, 3/45, H 01 T 23/00

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
IPC5	B 03 C; H 01 T

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in Fields Searched[8]

SE,DK,FI,NO classes as above

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category *	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
Y	SE, B, 453783 (ASTRA-VENT AB) 29 February 1988, see the whole document --	7,10
X Y X	US, A, 1931436 (W. DEUTSCH) 17 October 1933, see esp. figures 1-4,6,7,10,11,14,15 --	1,2,4-6, 8,15 7,10 11,12,14
X Y	US, A, 2871974 (M.C. WERST) 3 February 1959, see the whole document --	1,2,3 7,10

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* Special categories of cited documents:[10]

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

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"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance, the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance, the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
11th December 1991	1992 -01- 14
International Searching Authority	**Signature of Authorized Officer**
SWEDISH PATENT OFFICE	Johan Auby

ANNEX TO THE INTERNATIONAL SEARCH REPORT
ON INTERNATIONAL PATENT APPLICATION NO.PCT/SE 91/00664

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the Swedish Patent Office EDP file on 31/10/91
The Swedish Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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		AU-D- 6831487	87-07-15
		EP-A-B- 0277953	88-08-17
		JP-T- 63501991	88-08-04
		SE-A- 8506067	87-06-21
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US-A- 1931436	33-10-17	NONE	
US-A- 2871974	59-02-03	NONE	